Cryostat Thermal Model (CTM3) Preliminary results

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30/03/98

(Note: figures and graphs are not linked to this file, see p3,6,8 and10)

Head lines of the presentation

1. **Why a Cryostat Thermal Model ?**
2. **How to measure ?**
3. **Previous model results**
4. **The preliminary results for the CTM3**
5. **Further investigations**

1.Why a Cryostat Thermal Model ?

- **To measure on a full-scale dipole cryostat:**
  - **Heat Inleaks for various LHC possible condition environments**
  - **To validate the theoretical modeling**
  - **To complete the single component performance measurements**

- **High-level timing goal for CTM3/run1:**

  Adoption of an actively cooled screen @ 5 K ?
  - **Transient state**
  - **Steady-state nominal condition**
  - **Influence of the screen temperature**
  - **Influence of the insulation vacuum**

2. How to measure ?

- **Temperature and pressure instrumentation**

- **T>30 K: Pt100** **(100 μA, ΔT=0.2K @77K)**
- **T<30 K: Allen Bradley** **(1 μA, ΔT=4mK @4.2K et ΔT=20mK @30K)**
- **1.5<T<273 K: Cernox** **(1 μA, ΔT=1mK @4.2K et ΔT=10mK @100K)**

- **8E-4 < P [mbar] <1E3 : Pirani**
- **1E-9 < P [mbar] <1E-3 : Penning (3.3kV)**

- **Current source: 0.01%** **+/-** **@ 1.9 K**
- **Voltmeter (DVM): 1 μV** **==>** **+/-** **@ 4.5 K**
- **Mass-flowmeter: Δm < 2 %** **+/-** **@ 50 K_4**

Contribution of the extremity boxes

At 1.9 K

Feed box **364 mW**

At [4.5-20 K]

Return box **0.8 W**

At [50-75 K]

Return box **19.5 W**

Set of environment condition

Temperature range

TS : 50 K - > 75 K

RS : 5 K - > 20 K

Insulation vacuum range

P : 5E-4 - >1E-1 Pa

3. Previous cryostat models

- **Descriptions**
- **Results**
- **Conclusions**

CTM1 and CTM2 results:

Total loads

Heat inleak[W/m]	@ 50-75 K / Line E+F		@ 4.5-20 K / Line C+D		@ 1.9 K	
	measured	calculated	measured	calculated	measured	calculated
CTM1	4.78	4.58	0.23	0.24	0.18	
CTM2	4.32	4.12	0.48	0.33	0.15 (1)	0.12

(1)The contribution of the feed box on the measured heat inleak at 1.9 K is estimated to 0.314 W.

Heat inleaks for the two support posts

Heat inleak [W]	@ 50 - 75 K/ Line E		@ 4.5 - 20 K / Line C		@1.9 K	
	measured	calculated	measured	calculated	measured	calculated
CTM1	15.8	14.2	1.8	2.08	0.21	
CTM2	16	11.7	1.8 (2)	0.9	0.2	

(2) No sensor to confirm the calculation.

Screens performance

Heat inleak [W/m^2]	@ 50 - 75 K		@ 4.5 - 20 K / 24 Braids ETP	
	measured	calculated	measured	calculated
CTM1	1.2	1.09	0.09	0.08
CTM2	1.09	1.11	0.119(3)	0.102

(3) Interpretation with braid thermometers.

CTM3 expected results

- **Theoretical analysis : floating and actively cooled screen comparison**
- **Modelling of CTM3:**
- **Complementary tests:**
  - **Support post performance**
  - **MLI**
  - **Spacer**

4. CTM3 preliminary results

Total loads

Heat inleak[W/m]	@ 50-75 K / Line E		@ 4.5-20 K / Line C		@ 1.9 K	
	measured	calculated	measured	calculated	measured	calculated
CTM1	4.78	4.58	0.23	0.24	0.18	
CTM3	4.35	4.14	0.24	0.17	0.04 (1)	

((1)The contribution of the feed box on the measured heat inleak at 1.9 K is estimated to 0.314 W.

Heat inleaks for the two support posts

Heat inleak [W]	@ 50 - 75 K/ Line E		@ 4.5 - 20 K / Line C		@1.9 K	
	measured	calculated	measured	calculated	measured	calculated
CTM1	15.8	14.2	1.8	2.08		0.21
CTM3	12.80 (2)	13.58	1.20 (2)	1.64	0.08 (2)	0.10

(2) No sensor to confirm the calculation.

Screens performance

Heat inleak [W/m^2]@ 50 - 75 K			@ 4.5 - 20 K / 24 Braids ETP		@1.9 K	
	measured	calculated	measured	calculated	measured	calculated
CTM1	1.2	1.09	0.09	0.08		
CTM3	1.24	1.20	0.06 (3)		0.017	0.02

(3) Interpretation with braid thermometers.

Related Projects

- **Lumped cryogenic spacer thermal performance**
- **Influence of the outer layer of MLI blanket: Vitrulan**
- **Support post thermal performance**
- **Superinsulation outgassing measurements**
- **Superinsulation comparison**